PART FOUR

ESTIMATES OF MINER LOCATION ACCURACY: WESTINGHOUSE LOCATION PROGRAM "MINER"

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TABLE OF CONTENTS

PART FOUR

ESTIMATES OF MINER LOCATION ACCURACY:
WESTINGHOUSE LOCATION PROGRAM "MINER"

LIST OF TABLES

PART FOUR

ESTIMATES OF MINER LOCATION ACCURACY:
WESTINGHOUSE LOCATION PROGRAM" MINER"

LIST OF FIGURES

PART FOUR

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I. INTRODUCTION

Crosson and Peters treat the errors that result in miner location due to errors in the overburden earth model used for computing location. A parallel effort by J. Powell of PMSRC is discussed here, where the location method used is that of the Westinghouse location program - "Miner". This location program was tested by Powell by using arrival times generated from the overburden earth model of Table 1* rounded to the nearest millisecond. Location computations were then made using 3 geophones at a time. The average location is tabulated for all geophone triplets except when 3 geophones are in line. Geophone arrays were as shown in Tables 2 and 3. The manner in which the test was done is illustrated in Figure 1.

II. SUMMARY OF RESULTS

The arrival time differences, based on the Table 1 earth model, together with geophone locations based on the array geometries of Tables 2 and 3, were entered into the computer, together with a stated depth of 700 feet and an estimated overburden seismic velocity of 10,000 feet per second. These parameter values were processed by the location program - "Miner". Figure 2 illustrates the interpretation of the plots and data. The tabular data and plots of Table 4 and Figures 3, 4, and 5 illustrate the location error results obtained.

These plots indicate that for sources within the array, the errors are considerably less than the measured errors obtained during field tests of the present location system. The possible reasons for this discrepancy are noted in Part Eight (Earth Models).

*References to Figures, Tables, and Equations apply to those in this Part unless otherwise noted.

The work summarized here is based on arrival time differences resulting from one particular representation of the earth. Other representations of the earth will yield other results. When hard data has been developed on the real seismic properties of coal mine overburdens, much more definitive results concerning the location accuracy of program "Miner" can be developed.

It is further noted that the present test of "Miner" did not make any use of the overspecification of location that results from the use of seven arrival times to vary the model velocity used in computation. Figure 5 does illustrate the behavior of errors for an array judged to be too small for the known depth of source. For this example the dependence of location error on input velocity is shown.

Table 1

Earth Model

Layer Number	Layer Thickness (ft.)	Layer Velocity (ft/sec)
Surface		
1	5	1,500
2	15	2,000
3	30	3,000
4	50	4,500
5	100	6,000
6	200	8,000
7	300	11,000
Source		

Table 2

"L-Feet Hexagon" Array

Geophone No.	X	Y
1	0	0
2	L	0
3	L/2	.866 L
4	-L/2	.886 L
5	-L	0
6	-L/2	-.886 L
7	L/2	-.886 L

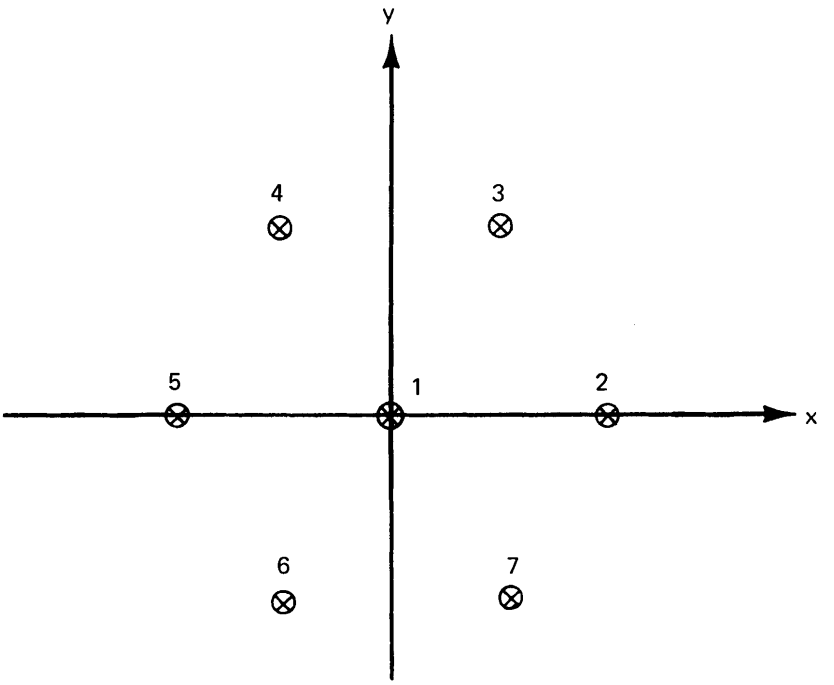
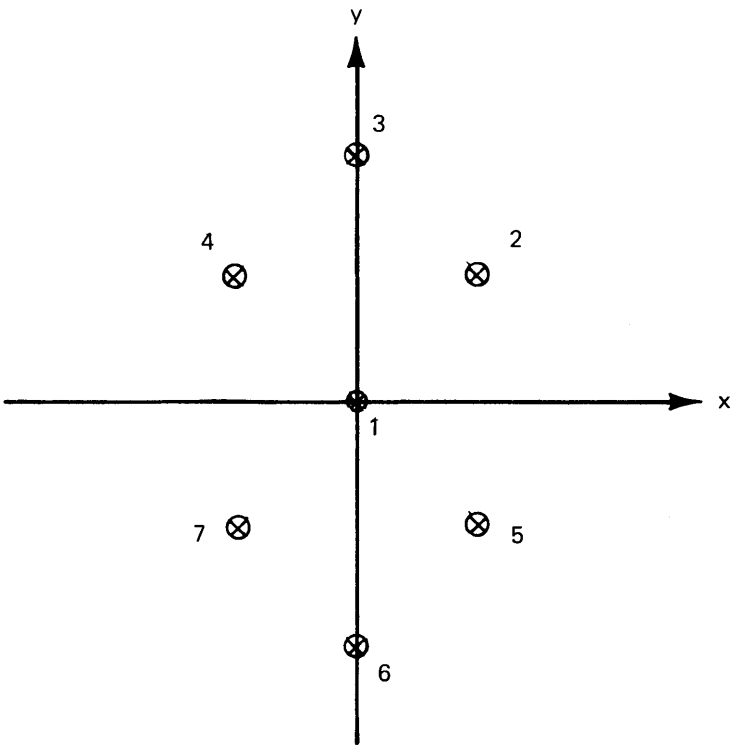


Table 3

"L-Feet Double-Square" Array

Geophone No.	X	Y
1	0	0
2	L	L
3	0	2L
4	-L	L
5	L	-L
6	0	-2L
7	-L	-L



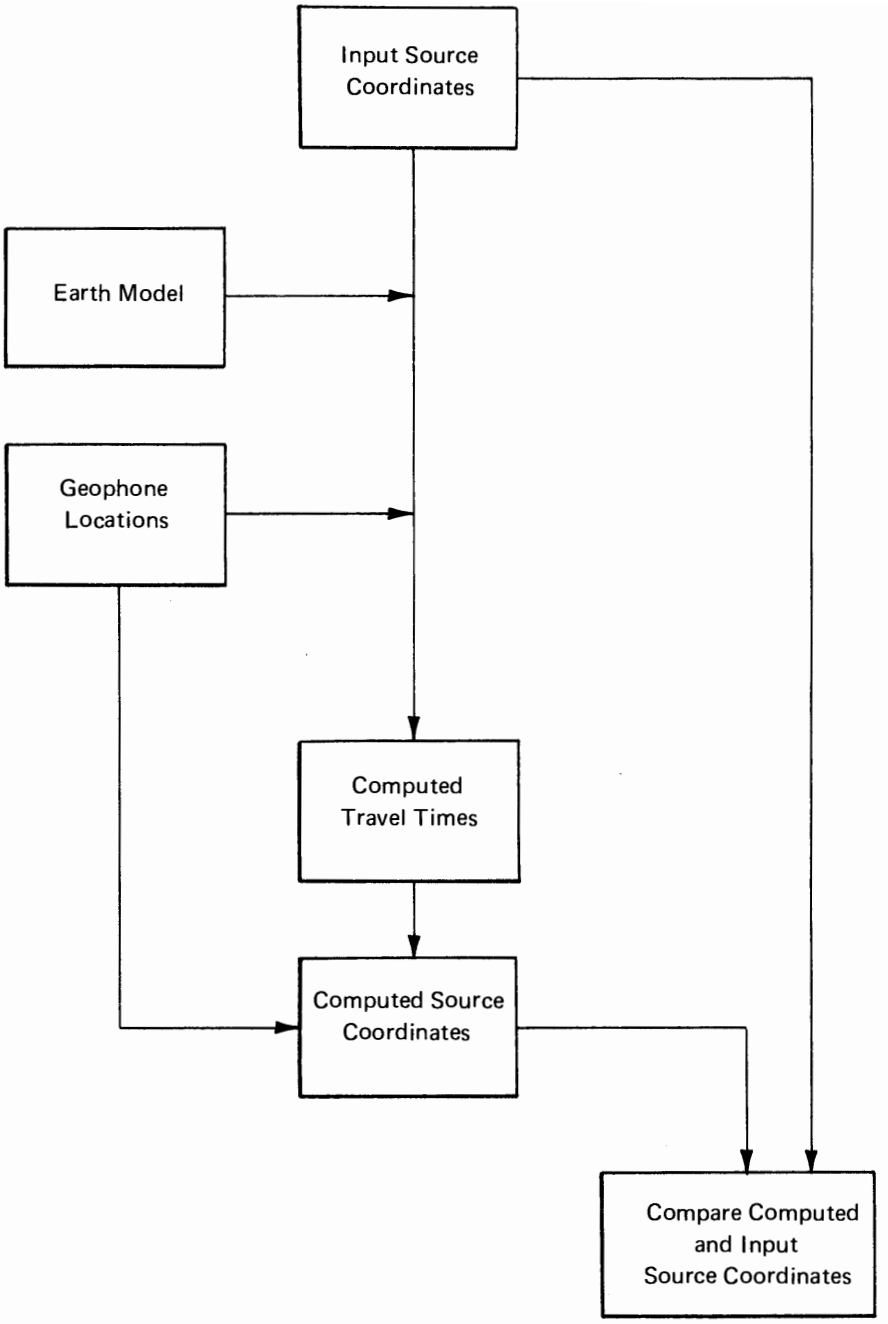
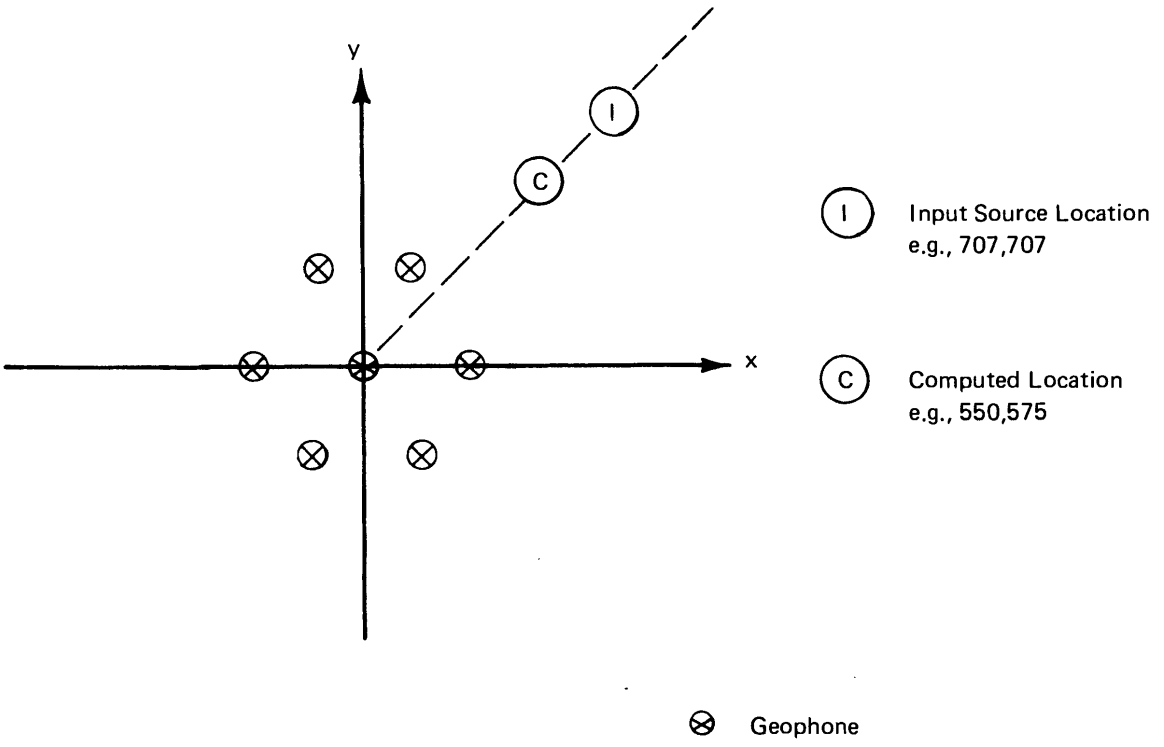


FIGURE 1 BLOCK DIAGRAM OF COMPARISON TEST



Note that:

1. The origin of the coordinate system is at the center of the array
2. The origins, I, and C are almost in a straight line
3. The distance from origin to I exceeds the distance from origin to C, so error is negative.

FIGURE 2 NOTATION USED IN ERROR GRAPH

Table 4

Error Data From "Miner" Location Program

Assumed Velocity = 10,000 Ft/Sec
True Depth = Assumed Depth = 700 Ft
D Refers to Error as Source Moved Along a Diagonal
X to Error as Source Moved Along X Axis
Y to Error as Source Moved Along Y Axis

a) Errors for 300 Feet Double Square Array

Source Distance (Feet) From Array Center	Error (Feet) in Computed Location		
	D	X	Y
2000	-1010	-354	-503
1400	154	-143	-123
1000	64	43	64
700	72	103	91
450	62	63	59
300	59	55	52
200	28	24	26
150	19	14	17
100	14	7	14
50	4	-2	-2
5	2	-7	-2

b) Errors for 400 Feet Hexagon Array

Source Distance (Feet) From Array Center	Error (Feet) in Computed Location		
	D	X	Y
2000	-373	-569	-532
1400	-106	-51	-124
1000	57	99	44
700	98	112	69
450	77	84	85
300	57	56	59
200	31	34	35
150	27	31	32
100	16	18	20
50	7	5	10
5	-5	-	-5

Table 4 (Continued)

Error Data From "Miner" Location Program

X Errors (Feet) for 3 Different Assumed Velocities
As Source Moved Along X-Axis
True Velocity Less than 8000 Ft/Sec
True Depth = Assumed Depth = 700 Ft

c) Effects of Assumed Velocity on Location Error for 150 Ft Double Square Array

Source Distance(Feet) From Array Center	Assumed Velocity in Ft/Sec		
	10,000	8,000	6,000
2000	-534	-1263	-1540
1400	-163	-713	-963
1000	-10	-407	-610
700	147	-143	-330
450	93	-55	-175
300	63	-31	-108
200	35	-21	-70
150	29	-12	-50
100	26	-3	-30
50	1	-13	-4
5	-5	-7	-8

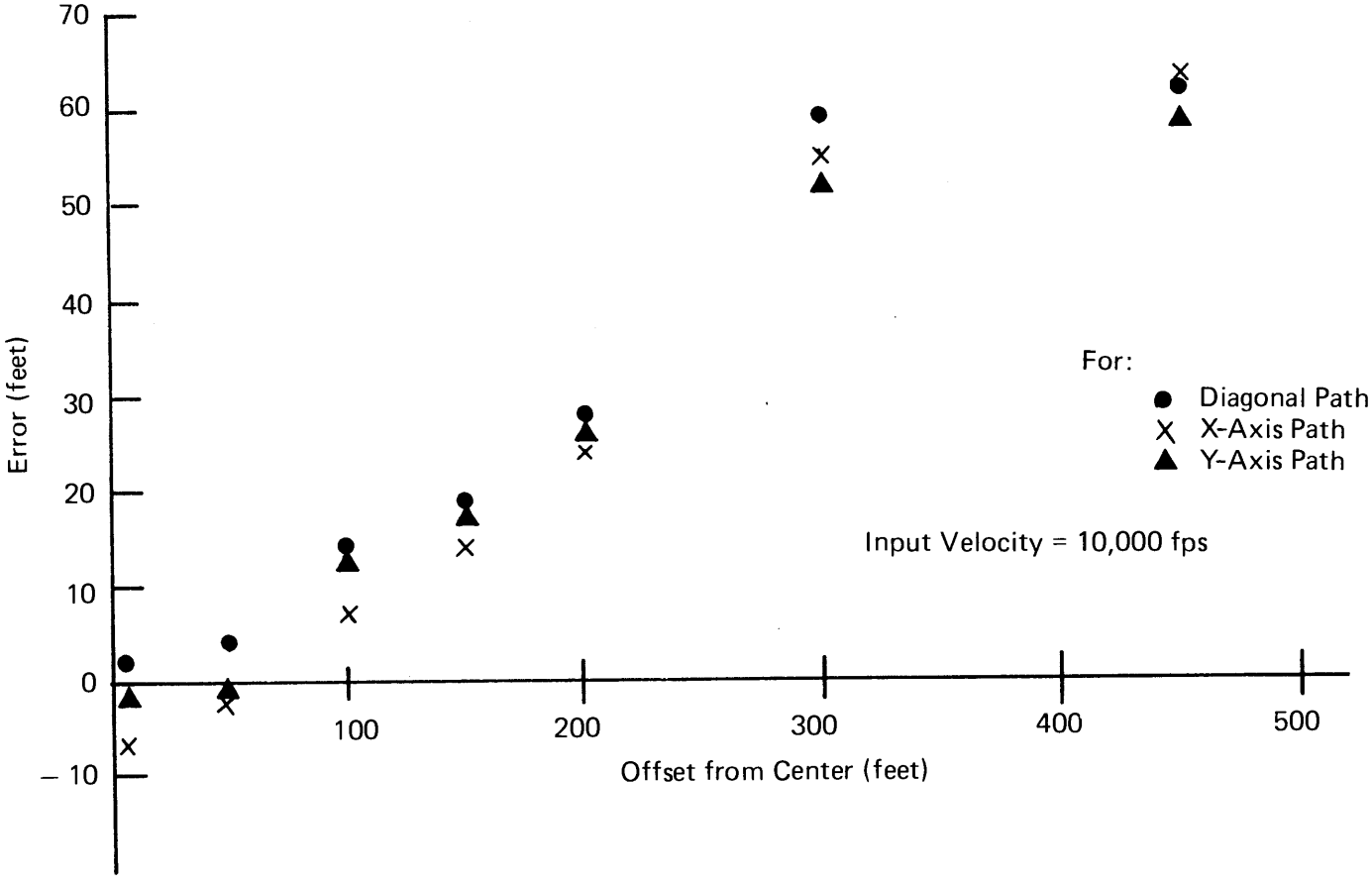


FIGURE 3 "MINER" LOCATION ERROR 300 FOOT DOUBLE SQUARE

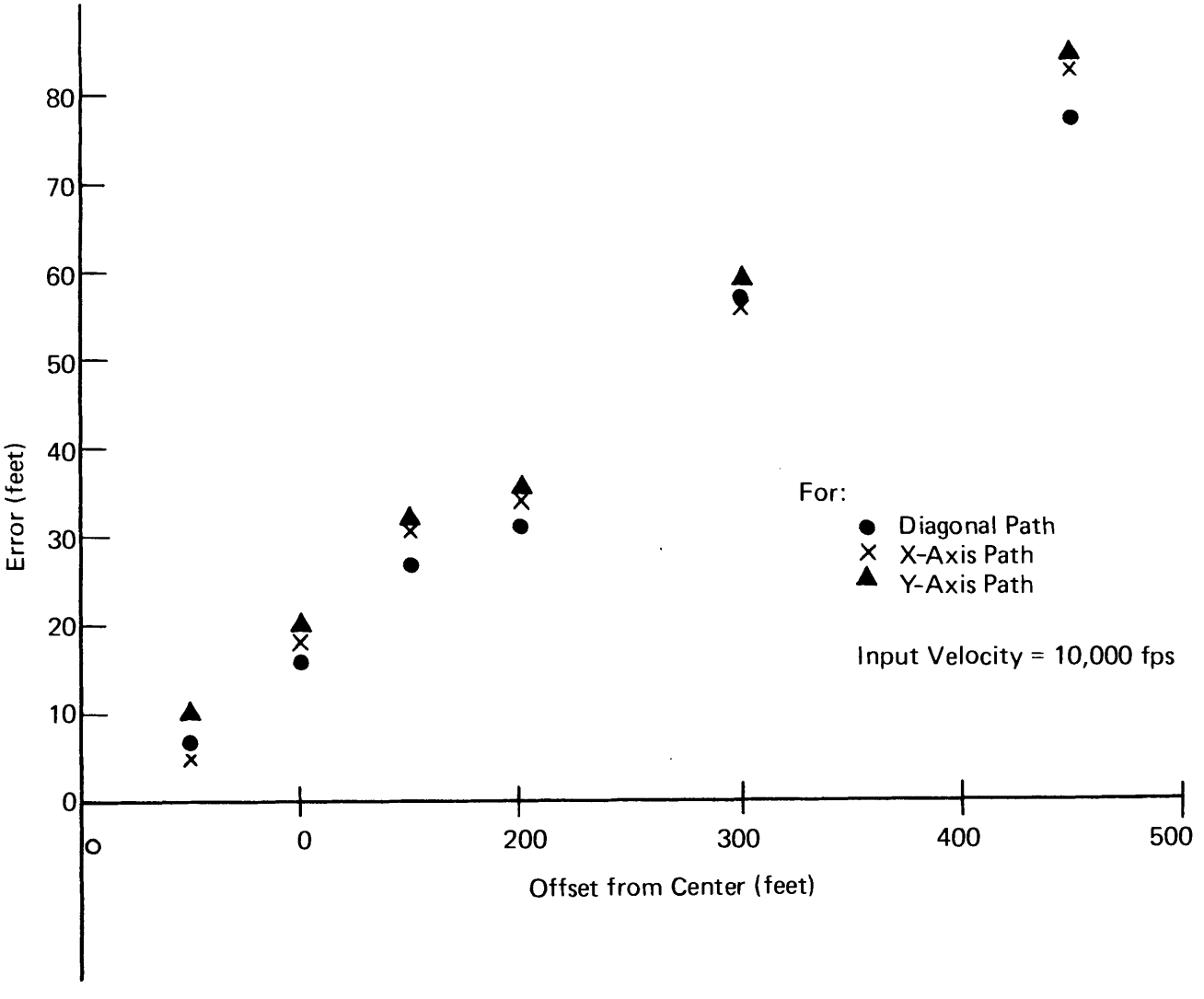


FIGURE 4 "MINER" LOCATION ERROR 400 FOOT HEXAGON

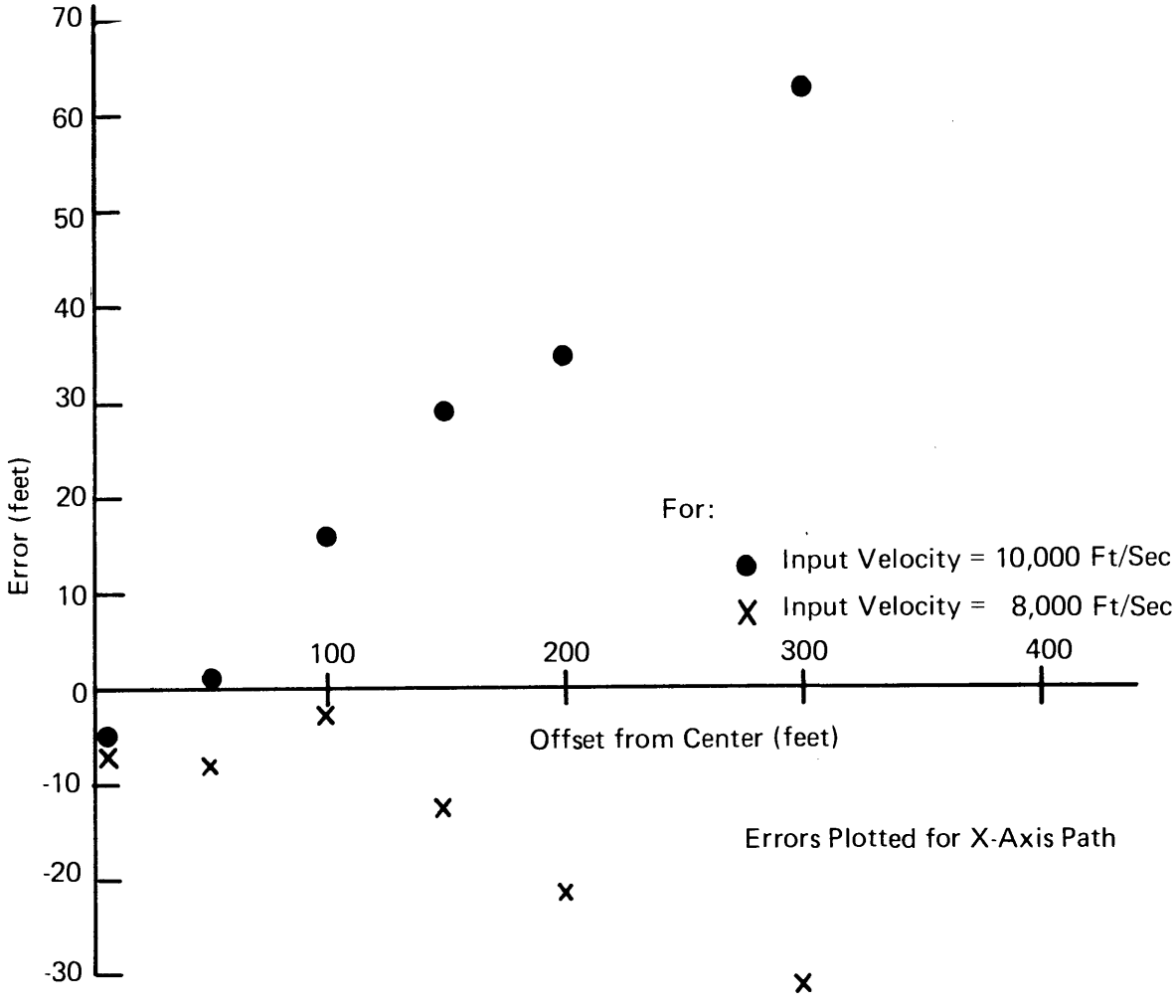


FIGURE 5 "MINER" LOCATION ERROR
150 FOOT DOUBLE SQUARE